Rehabilitation Game Model for Personalised Exercise

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***Abstract*- Existing literature has shown that games and virtual reality can help motivate people thus keeping them engaged for longer. Nonetheless, in most approaches the design of games or virtual reality for rehabilitation purposes tend to apply a basic motivational approach that focuses on the general population of game players. Recent research shows that individuals can be motivated quite differently and so it may be important to consider each individual's motivational characteristics within the context of rehabilitation to ensure continued engagement. In this paper we present the Rehabilitation Game Model (RGM), which can be used as a basis for evaluating existing systems and for designing new interactive rehabilitation systems that are more personalised and engaging. Initial evaluation of existing rehabilitation games and comparison with commercial games using the RGM indicate a potential over emphasis on achievement based reward systems in rehabilitation game design compared to other reward systems.**

Keywords— rehabilitation, game design, gamification, motivation, user types;

I. INTRODUCTION

Virtual reality and games have provided one way to promote adherence to exercise due to their potential to add engaging and enjoyable characteristics [1]. Insightful design of rehabilitation games is crucial in ensuring that the engaging characteristics of games are utilized appropriately. Games are created on the basis of design principles that have been established through collective and personal experience [2–4]. These design principles along with core game mechanics provide a focus for a game designer in the creation of a game that builds on game grammar and culture to design novel gameplay that engages players. Researchers and game designers have recognized that there are variations in the way players choose to interact in games and how they may be engaged and motivated to play games [5–8].

Non adherence to exercise can be very high and it has been shown that exercise interventions which include behavior change components can increase adherence [9]. There has been much research in the field of behavior change with many frameworks and theories proposed. COM-B (Capability, Opportunity, Motivation for Behavior change) is a new model for behavior change which utilizes a Behavior Change Wheel (BCW) to facilitate analysis of the context and implementation of an intervention [10]. BCW has been developed on the basis of 19 behavior change frameworks identified within a systematic literature review and provides the intervention functions for altering COM towards a target behavior, and explains ways to deliver the interventions to individuals or groups. At the core of the BCW circle are the three crucial factors that impact behavior change: Capability, Opportunity or Motivation (COM). The BCW facilitates a focus on these factors in order to identify aspects of a current behavior that needs to be changed, to persuade a new more positive behavior towards an issue.

The aim of this paper is to present a new approach to designing and evaluating interactive rehabilitation systems that is more sensitive to user personality. We present the Rehabilitation Gaming Model (RGM) and demonstrate how it may be used to evaluate existing systems. Illustrating how it may be used to provide a structured approach to designing and developing new interactive rehabilitation systems that are more tailored to the individual. The development of the RGM is the first phase in the design of a novel personalised and adaptive upper arm rehabilitation system, which in the future will use natural user interfaces incorporating Leap Motion, Kinect, and Myo as sensors and input devices. The RGM emerged by fusing important new ideas on gamification user types research with a comprehensive ontology of game design patterns and merging these with fundamental psychological principles on behavior change from the COM-B framework. An online tool has been created to facilitate the application of the RGM in the design of interactive rehabilitation software. The core detail of the RGM is presented and it is evaluated by analysing both popular mainstream commercial games as well as existing rehabilitation games from literature.

II. BACKGROUND

Games are considered to be highly engaging forms of interactive entertainment and this is key reason why a number of frameworks have proposed the use of games to help in the design of engaging rehabilitation [10, 11], including the mapping of game design patterns to physical motion required in stroke rehabilitation [13]. Games may be broken down and understood by their component parts (or underlying mechanics) and a number of authors have attempted to develop structured methods for describing and designing games on this basis. Approaches include the building of a comprehensive game design pattern ontology [17] and the use of comprehensive game feature lists [13, 14]. These classifications of game design components provide a structured way to design novel gameplay and provide a common language for expressing gameplay ideas. This common language of gameplay creates a paradigm for developing good and interesting games. For example, Schell [16] created a method to evaluate games through the use of a

deck of lenses. The lenses are intended to be used before, during or after the completion of a game to help the designer be reflective about the design process and their game designs. Through problem identification the games can be improved upon to ensure that a fun game is developed. In A Theory of Fun [17] Koster describes his view on what makes a game fun and engaging, proposing that humans tend to enjoy finding and following new patterns in games, learning from them until they have mastered the pattern. When mastered people get bored and stop playing. According to him a good game is "one that teaches everything it has to offer before the player stops playing".

Gamification is increasingly becoming a popular term and it describes an approach to help make non-game processes such as training more engaging or fun, to increase productivity of workers, or improve user retention for online services [17, 18]. Part of the focus in Gamification is to make existing and monotonous tasks seem more enjoyable by applying the motivational techniques derived from and mechanics and feedback mechanisms games. The most popular feedback systems used to gamifiy applications are centered on the use of rewards and social status [20]. Gamefulness is another term that is closely related to gamification. McGonigal [21] coined the term suggesting that gamefulness is the act of being game-like in the approach to playing games, where gamefulness involves the use game elements such as role playing, story and agency and argues that this is where engagement is situated not in feedback mechanisms.

Many researchers and game designers have identified variations in the way players interact and in particular the manner in which they are motivated by different aspects of games and gamified systems. The most notable and early player typology for games was established by Bartle [5]. He proposed four fundamental player types through analysis of player behavior and interaction within Multi-User Dungeons (MUDs), which form the basis of much research in the area including the Hexad gamification typology [22]. The Hexad defines six core types of people based on the ways they respond to gamified feedback/reward and is the gamification model that we use for our RGM. Other researchers also consider the behavior of players in games, for example linking it to behavioral psychology such as Temperament Theory and Myers Briggs' 16 personality types [7].

Behavior change approaches have been used widely in society to attempt to change the destructive behavior of individuals or groups towards a more positive and less harmful behavior. One recent approach to behavior change is the Behavior Change Wheel (BCW) [10]. The BCW was formed from nineteen other frameworks identified from a systematic review. As identified earlier the core of BCW is the COM-B model of behavior change, the model highlights that behavior is part of an interacting system comprised of all the COM components. Therefore in order to change behavior one or more of these components need to be changed. BCW also identifies nine intervention functions that can be applied to change each of the components and policies that can be adopted to deliver the intervention functions. A detailed list of behavior change techniques (BCTs, n=93) has been identified which can be used to address the COM-B deficits. The BCTs have been used a number of times throughout literature. For example, they have been used to recognize the methods to increase physical activity and healthy eating, by identifying the possible problems associated with physical activity and healthy eating and applying the BCTs as solutions [23].

III. Rehabilitation Game Model

The RGM comprises three core aspects, a gamification typology system [24], a game design pattern ontology [14], and a behavioral change framework [10], which when accrued provide a structured approached to designing and evaluating games for rehabilitation.

The gamification typology used is Marczewski's Hexad, which contains six Gamification types. We have previously utilized an earlier version of this typology effectively in an educational context [25] and so the Hexad proved a natural choice. In addition, the user types are based on well-known player types [5], and other psychological personality models including Self-Determination Theory. It also has proven to be a good fit with the behavioral model and design pattern ontology. The six gamification user types are:

1. **Disruptor** – motivated by *change* they want to disrupt the system directly or through others with a positive or negative outcome.
2. **Free Spirit** – motivated by *autonomy* they want to explore be creative and have choices.
3. **Achiever** – motivated by *mastery* they are all about self-improvement and like to be challenged in order to better themselves.
4. **Player** – motivated by *rewards* they are selfish and do what is necessary to win or be better than others.
5. **Socializer** – motivated by *relatedness* they want to create a social connection with others.
6. **Philanthropist** – motivated by *purpose* they need a purpose for interacting and are also altruistic towards others.

As discussed earlier there are many ways to represent the mechanics of a game from a designer perspective though perhaps none as comprehensive as Bjork and Holopainen's 295 ontology of game design patterns [26]. Not only are all of the patterns categorized, facilitating our use in the RGM, but these design patterns have been used previously in application to game rehabilitation research [11, 12] and so the ontology was a logical choice for our application to the RGM. The 295 patterns are split across 11 categories: Game Elements, Resource Management, Information Communication Presentation, Actions and Events, Narrative Predictability and Immersion, Social Interaction, Goals, Goal Structures, Game

Sessions, Game Mastery and Balancing, Replayability and Learning Curves.

We utilize the new COM-B [10] system for the RGM as it is built upon nineteen existing, established behavior change frameworks. COM-B incorporates the BCW framework for the provision of BCTs. BCT describes a range of intervention functions that can be used to address a deficit in COM-B, such as educating, persuading, incentivizing individuals or groups to encourage a behavior change affecting either or all of the COM components.

Using these three models in conjunction the RGM has been developed (see fig 1). We combine methods for shaping user behavior to engage in rehabilitation games through capability, opportunity and motivation and game design patterns providing the underlying game design techniques for each of the individual gamification user types and their reward or reputation systems. Reward/reputation systems are forms of feedback techniques predominantly used in gamification to motivate the user e.g. Points and Achievement Badges. The RGM provides a systematic means of designing gameplay systems suited to player personalities, towards developing a more positive attitude to adherence to rehabilitation exercises. Appendix A provides a detailed outline of the RGM model and shows the fusing of each gamification user type and their reward/reputation systems to the comprehensive range of game design patterns, along with the BCTs of BCW. By building this comprehensive mapping we enable a structured and logical approach to building gamified applications for rehabilitation; providing an insight into aspects of games that directly affect the typical feedback mechanisms of gamified applications with a specific focus on psychological motivations of different people. RGM also highlights facets of games that could promote a behavior change in individuals who are motivated by different things, thus increasing the possibility of maximizing user retention across a population of users.

Fig. 1 represents a high level view of the components involved with RGM. The core component is the game and its mechanics. The mechanics are designed according to the gamification user types related to the player types in the player component. Similarly, the COM-B behavior techniques are organized to relate to a particular group of game mechanics and thus player type. Player *interactions* on the game mechanics (Dynamics) result in change of game state and the provision of *feedback* to the player. The player's interactions with the mechanics determine their player type with feedback being reflective of that particular player type. Feedback to the player can be visual, auditory, or haptic give is central to the user experience (Aesthetics). Game mechanics can *promote* certain *behavior changes* according to the challenges brought about by the particular player type's interactions on the games mechanics. For example a Free Spirit may use exploration (game mechanic) to explore a game world (interact) and receive a reward based on discovering new areas (feedback, behavior technique (Material rewards) & aesthetics).

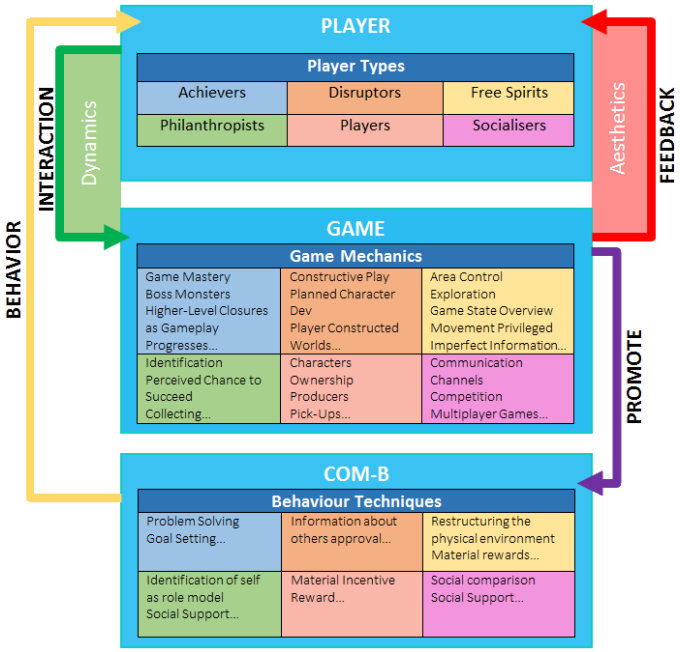

Fig. 1. High level view of the RGM

The RGM can be used in two main ways. Firstly, it may be used as a design tool enabling designers to brainstorm and communicate rehabilitation game ideas or concepts. The RGM articulates a method of designing gameplay; aiding the designer to deliver effective and relevant gameplay through the use of game design patterns suited to a range of personalities and rehabilitation exercises. The RGM is a design tool and can be used to communicating design ideas and so should be used from the beginning of rehabilitation game design process. Researchers, designers, clinicians and other stakeholders should decide on the rehabilitation exercises required for the patient to perform within games to ensure design compliments rehabilitation. Secondly, the RGM can be used as an assessment tool for the evaluation of existing rehabilitation or purely entertainment based games. For example, commercial off-the-shelf (COTS) games may be analyzed to provide an insight into aspects of COTS that may be useful in personalized rehabilitation. In addition the assessment of COTS may also identify games already suited for personalized rehabilitation. Researchers and designers of rehabilitation games can use the RGM to evaluate their systems during developing and at the end of development to ensure they provide a motivating and personalized rehabilitation game.

IV. RGM Application and Evaluation

To evaluate the RGM five popular commercial games from different core genres were selected for analysis along with three relevant rehabilitation games. The approach requires the evaluator to play or observe video of gameplay and note all of the game design patterns that link to gamification features as

described in the RGM (Appendix A). To aid visual interpretation of the results we have developed a simple grading system to quantify and visualize the degree of impact of each of the six Hexad gamification factors on a game's underlying mechanics and gameplay. When the game is fully evaluated we sum all the reward and reputation systems for each user type, divide by the maximum number of reward and reputation feedback systems (max 6) and multiply by ten to calculate a score out of ten.

A. *Commercial Games*

As there are many successful commercial entertainment focused games available for review and analysis, an inclusion criteria was set to find the single most popular game from each of five of the core game genres: Action, Adventure, Role Playing, Simulation and Strategy. Using Metacritic (http://www.metacritic.com/), a website that aggregates reviews of all forms of entertainment including games, all games with a user score greater than 8.5 were gathered and those with the highest user score were selected. Where games received an equal score the game with the highest Metacritic reviewer score was selected. Table I shows the commercial games chosen under the inclusion criteria.

TABLE I
COMMERCIAL GAMES THAT MET INCLUSION CRITERIA

Genre	Game	User score
Action	Half Life 2 (HL2)	9.2
Adventure	Grim Fandango (GF)	9.2
Role Playing	Planescape Torment (PT)	9.4
Simulation	Free Space 2 (FS2)	8.9
Strategy	StarCraft (SC)	9.2

TABLE II
RGM EVALUATION RESULTS OF COMMERICAL GAMES

User Type	HL2	GF	SC	FS2	PT
Disruptor	0	1.67	3.3	0	1.67
Free Spirit	3.3	8.3	6.67	1.67	6.67
Achiever	8.3	6.67	8.3	6.67	8.3
Player	1.67	0	5	3.3	5
Socialiser	0	0	10	6.67	0
Philanthropist	3.3	5	5	1.67	3.3

Through observation of gameplay videos and using the RGM to evaluate each game an RGM profile was established (Table II). The RGM game profiles illustrate that these five commercial games, when taken together, contain design patterns relevant to all of the gamification user types with each game exhibiting at least one dominant user type. Unsurprisingly, all games demonstrate an emphasis on the Achiever attribute, only fluctuating in the specific design patterns and reward or reputation systems. Only one game displayed a profile with scores across all gamification types; StarCraft is a real-time strategy game and is part of a genre that naturally encompasses a variety of player types. Unsurprisingly, for the games selected, they had a relatively low score with respect to the Disruptor attribute. Fig. 3 shows the results visualized on a radar diagram providing a view of the impact each game has on each gamification attribute.

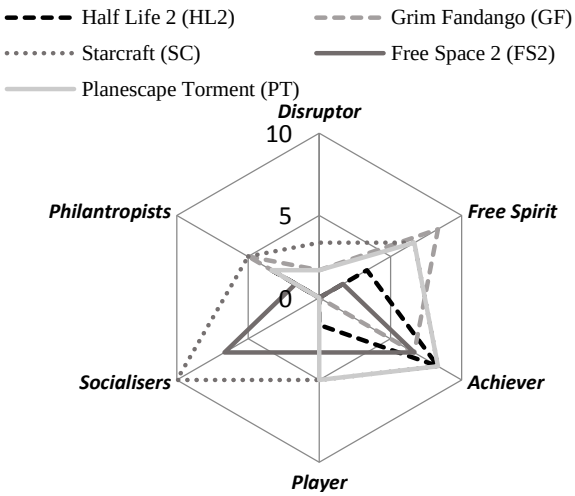

Fig. 2. RGMs Evaluation of Commerical Games

Table III shows the actual design patterns discovered per gamified user type in the game Grim Fandango (N.B. due to space restriction it was not possible to show this detail for all games). The combination of information in Tables II and III provides an RGM profile for each game.

TABLE III
DETAILED GAMIFICATION USER TYPE AND GAME DESIGN PATTERN RELATIONSHIPS FOR GRIM FANDANGO

DISRUPTOR
Development Tools: *Tools, Constructive-Play.*
FREE SPIRIT
Exploration: *Controllers, Inaccessible-Areas, Imperfect-Information, Movement, Exploration, Cognitive-Immersion*
Branching Choices: *Freedom-of-Choice, Limited-Set-of-Actions.*
Easter Eggs: *Pick-ups*
Unlockable/Rare Content: *Resource-Generators*
Creative Tools: *Empowerment.*
ACHIEVER
Challenges: *Movement, Obstacles, Rescue, Puzzle-Solving*
Quests: *Collection, Traverse, Committed-Goals, Hierarchy-of-Goals*
Learning/New Skills: *Experimenting, Memorizing*
Levels/Progression: *Levels, Resources*
PHILANTHROPIST
Access: *Buttons, Tools, Controllers*
Meaning/Purpose: *Identification*
Collecting & Trading: *Pick-Ups, Tools, Collecting, Gain-Ownership.*

B. *Rehabilitation Games*

A considerable number of rehabilitation systems have been developed by designers and researchers for experimental research in recent years. However, many have very simple gameplay dynamics [27] and of those that do have more complex game designs not all are well explained in the literature. We choose three rehabilitation game systems that have been referenced in published research where videos of the gameplay was available, thus facilitating our evaluation. Each of the three systems (Table IV) comprised a suite of games and thus potentially could cover a range of game

features that would appeal to different user personalities and gamification type.

TABLE IV
REHABILITATION GAMES FOR EVALUATION

Authors	Games
Serradilla [28]	Circus Challenge
Burke et al [29]	Rabbit Chase, Arrow attack
Nirme et al [30]	Rehabilitation Gaming System

Table V shows the RGM profile for each of the evaluated rehabilitation games and indicate, somewhat contrary to expectation, that the suite of games within each system are quite narrow in their approach to designing variation of appeal to a range of user gamification types. Fig. 4 provides a graphical representation of the three rehabilitation game system's RGM profiles and highlights a dominance of two gamification attributes embedded within the design of the games: Achiever and Player. The Achiever attribute of the RGM being the dominant type throughout each suite of games and reflecting a particular focus on challenge oriented reward systems embedded in the game designs. The Player attribute is present in all game systems analyzed but to a lesser degree, and represents mainly extrinsic reward and feedback systems (i.e. rewards that are independent of a player's potential to progress further, but often simply relate to progress signposts, e.g. achievement badges). In this analysis the rehabilitation system with the most RGM features was Circus Challenge from Limbs Alive, exhibiting a higher valued RGM profile in comparison to the other rehabilitation games.

Table VI displays the game design patterns extracted from the Limbs Alive suite of rehabilitation games through observation with their associated gamification user types and their reward/reputation feedback systems. This highlights the strong emphasis on Achiever gamification related design patterns within Limbs Alive within its RGM profile. The RGM provides a method for developing RGM profiles that can be used to help evaluate and compare games based on their applicability to a range of user types (based on a personality based gamification typology). In this way it can be seen that it is not necessarily intended for conducting statistical analyses but is a subjective tool to aid understanding and communication in a design context.

All of the commercial and rehabilitation games evaluated exhibit RGM profiles that provide a strong indication of a predominant emphasis of the Achiever attribute. As discussed previously, it is quite natural that game designs would center on supporting players to progressively develop skill in order to complete increasingly difficulty goals so as to advance through a game. An Achiever type is based around a person being intrinsically motivated to progress and providing reward/feedback to that player to support their intrinsic goals. A game designer intuitively creates gameplay with this achievement dynamic at the core for challenge-based games. However, modern commercial games increasingly incorporate game design patterns that account for a wide range of player type, StarCraft being a good illustration of this in our study.

The rehabilitation game systems that we evaluated, while containing well-designed and entertaining games, nonetheless had a narrow design focus on achievement-oriented rewards. Arguably, this is a less suitable focus in a rehabilitation context, as there may be issues in dealing with failure and rehabilitation. In addition, it may also be argued that a "gamer" population would be more likely to be comprised of people who are naturally interested in challenges, whereas a group of people engaged in rehabilitation (e.g. stroke rehab.) are more likely to be engaged by broader system features such as social and creative factors. It may be that for some people the gamification of social networking, interactive digital art and other interactive non-game software may be more appealing and provide a suitable context for developing interactive rehabilitation software with more inclusive RGM profiles.

TABLE V
RESULTS OF EVALUATION OF THREE UPPER LIMB REHABILITATION GAME SYSTEMS

User Type	LA	JB	RGS
Disruptor	0	0	0
Free Spirit	0	0	0
Achiever	8.3	6.67	5
Player	1.67	1.67	1.67
Socialiser	0	0	0
Philanthropist	0	0	0

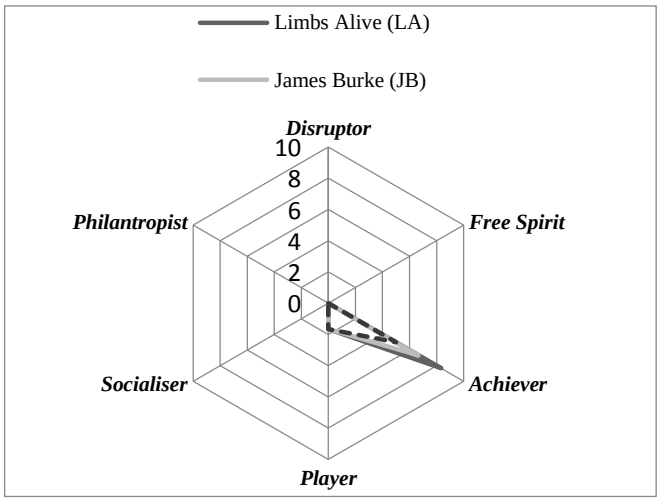

Fig. 3. RGMs Evaluation of Rehabilitation games for Upper limbs

TABLE VI
DETAILED GAMIFICATION USER TYPE AND GAME DESIGN PATTERN RELATIONSHIPS FOR LIMBS ALIVE

ACHIEVER
Challenges: Movement, Alignment
Certificates: *Game-Mastery*
Quests: *Committed-Goals*
Learning/New Skills: *Experimenting, Skills, Gain-Competence*
Levels/Progression: *Levels, Score, Skills, Smooth-Learning-Curves*
PLAYER
Points/Exp Points (XP): *Score, Outcome-Indicators*

V. Conclusion

The Rehabilitation Game Model (RGM) was introduced as a design tool for creating and evaluating rehabilitation games, incorporating a gamification typology and taking into account variation between types of people in the way that they may be motivated. In the RGM gamification types are mapped to game design patterns and also have a basis in psychology and personality models. Behavior change techniques are also integrated in order to shape behavior and help tailor games to encourage improved adherence to exercise. The RGM has been created to guide the design and implementation of effective rehabilitation games but may also be used to analyze existing games, to evaluate whether they have a potential appeal to a wide range of people. The outcome from using the RGM to evaluate five commercial and three rehabilitation games have been presented. Top rated commercial games from five core genres were rated based on their applicability to six core gamification types based on their inherent game mechanics (design patterns). It can be seen that there is clear variation in potential appeal between the games based on our analysis and that some games (and potentially genres) For example, StarCraft incorporates mechanics and rewards systems that appeal to a wider range of player type than other games such as Half-Life 2, which have a greater emphasis on challenge based achievements. In contrast the rehabilitation games that were evaluated all have a strong focus on achievement dynamics. It is perhaps natural that this should be the case due to strong linkage between goal oriented structures and mental or physical progress. It is also important to note that it is not unexpected that the quality of design between commercial and research based games may vary considerably, and that professional game designers may intuitively (or deliberately) incorporate features that ensure appeal to a wider user group. Nevertheless, this initial application of the RGM highlights a potentially significant issue in the design of rehabilitation games; specifically that if the designer does not account for variation in personality type in designing games for a broad appeal then the software created may not be as effective as it could be. Future work will involve expanding the RGM to include further behavior change techniques in the model and to expand the number of games analyzed. When complete the RGM will be used to design novel and more inclusive games for physical rehabilitation which will then be evaluated for their effectiveness.

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APPENDIX A: Detailed RGM showing game design pattern and BCW taxonomy mapped to gamification user types and associated reward/reputation systems

Gamification User Type : Achiever		
Reward/Reputation System	**Game Design Patterns**	**Behavior Change Techniques Taxonomy**
Challenges	Alignment, Deadly Traps, Enemies, Evade, Guard, Limited Resources, Maneuvering, Obstacles, Overcome, Player Killing, Puzzle Solving, Race, Rescue, Time Limits	Problem Solving, Graded tasks
Certificates	Competence Areas, Game Mastery, Producers	
Quests	Collection, Committed Goals, Continuous Goals, Dynamic Goal Characteristics, Ephemeral Goals, Excluding Goals, Goal Points, Hierarchy of Goals, Incompatible Goals, Interferable Goals, King of the Hill, Mutual Goals, Near Miss Indicators, Optional Goals, Predefined Goals, Selectable Sets of Goals, Supporting Goals, Symmetric Goals, Unknown Goals, Conceal, Configuration, Connection, Delivery, Traverse	Goal Setting(behavior + outcome)
Learning/New Skills	Achilles' Heels, Character Development, Experimenting, Gain Competence, Gain Information, Handicaps, Memorizing, New Abilities, Perceived Chance to Succeed, Power-Ups, Privileged Abilities, Reconnaissance, Role Reversal, Skills, Symmetry	Problem Solving, Instruction on how to perform a behavior, Demonstration of the behavior, Associative Learning, Behavioral practice/rehearsal
Boss Battles	Boss Monsters, Higher-Level Closures as Gameplay Progresses	
Levels/ Progression	Diminishing Returns, Improved Abilities, Levels, Obstacles, Producers, Red Queen Dilemmas, Resources, Score, Skills, Smooth Learning Curves, Higher-Level Closures as Gameplay Progresses	Behavioral practice/rehearsal, Remove punishment

Gamification User Type: Disruptor		
Reward/Reputation System	**Game Design Patterns**	**Behavior Change Techniques Taxonomy**
Anarchy	Betrayal, Player Elimination	
Light Touch	Bluffing, Damage, Limited Planning Ability, Paper-Rock-Scissors, Randomness, Red Herrings, Role Reversal, Secret Alliances, Uncertainty of Information	
Anonymity	Asymmetric Information, Bluffing, Cards, Fog of War, Handles, Paper-Rock-Scissors, Role Reversal, Secret Alliances, Stealth	
Development Tools	Constructive Play, Planned Character Development, Tools	
Voting/Voice	Betrayal	Information about others approval
Innovation Platform	Player Constructed Worlds, Player Decided Results, Player Defined Goals, Player-Decided Distribution of Rewards & Penalties, Reconfigurable Game World	

Gamification User Type: Free Spirit		
Reward/Reputation System	**Game Design Patterns**	**Behavior Change Techniques Taxonomy**
Exploration	Area Control, Exploration, Game State Overview, Maneuvering, Movement, Movement Limitations, Privileged Movement, Traces, Controllers, Imperfect Information, Inaccessible Areas	
Branching Choices	Analysis Paralysis, Asymmetric Goals, Attention Swapping, Betrayal, Cognitive Immersion, Freedom of Choice, Illusion of Influence, Limited Set of Actions, Planned Character Development, Risk/Reward, Roleplaying, Stimulated Planning, Tradeoffs	
Easter Eggs	Pick-Ups, Resource Locations, Secret Resources, Easter Eggs	Material Incentive(behavior), Material reward(behavior)
Unlockable/ Rare Content	Progress Indicators, Resource Generators, Rewards, Surprises, Ultra-Powerful Events	
Customisation	Camping, Characters, Construction, Player Defined Goals, Player Constructed Worlds, Player-Decided Distribution of Rewards & Penalties, Reconfigurable Game World	Restructuring the physical environment
Creativity Tools	Creative Control, Empowerment, Player Constructed Worlds, Player Decided Results, Player Defined Goals, Player-Decided Distribution of Rewards & Penalties	Restructuring the physical environment

Gamification User Type: Philanthropist		
Reward/Reputation System	**Game Design Patterns**	**Behavior Change Techniques Taxonomy**
Access	Asymmetric Goals, Buttons, Chargers, Tools, Controllers	
Meaning/Purpose	Identification, Perceived Chance to Succeed	
Care-taking	Helpers, Safe Havens, Tension, Tied Results, Mule	Social Support(un-specified), Social Support(practical), Social Support(emotional)
Collect & Trade	Bidding, Collecting, Contact, Converters, Enclosure, Gain Ownership, Negotiation, Pick-Ups, Reconnaissance, Safe Havens, Tools, Tradeoffs, Trading	
Sharing Knowledge	Cooperation	Social Support(un-specified), Social Support(emotional), Identification of self as role model
Gifting/Sharing	Cards, Cooperation, Card Hands	Social Support(un-specified), Social Support(practical)

Gamification User Type: Player		
Reward/Reputation System	**Game Design Patterns**	**Behavior Change Techniques Taxonomy**
Points/ Exp Points (XP)	Budgeted Action Points, Characters, Consumers, Container, Outcome Indicators, Score	Cue Signaling rewards, Material Incentive(behavior),Self-reward, Reward (outcome)
Physical Rewards/Prizes	Chargers, Illusionary Rewards, Individual Rewards, Non-Renewable Resources, Pick-Ups, Player Decided Distribution of Rewards & Penalties, Power-Ups, Renewable Resources, Resource Generators, Resource Locations, Resources, Rewards, Secret Resources, Symmetric Resource Distribution	Cue Signaling rewards, Material Incentive(behavior), Material reward(behavior), Non-specific reward(include positive reinforcement), Social reward, Social incentive, Non-specific incentive, Self-incentive, Incentive(outcome), Self-reward, Reward (outcome), Reward approximation, Reward completion, Situation specific reward, Reward incompatible behavior, Reward alternative behavior
Leaderboards/Ladders	High Score Lists, Red Queen Dilemmas, Tiebreakers	Self-monitoring of behavior, Self-monitoring of outcome(s) of behavior, Social comparison
Badges/Achievements	Characters, Ownership, Producers	Graded Tasks
Virtual Economy	Arithmetic Rewards for Investments, Budgeted Action Points, Consumers, Container, Geometric Rewards for Investments, Investments, Limited Resources, Ownership, Pick-Ups, Renewable Resources, Resource Locations, Rewards	Cue signaling rewards, Material Incentive(behavior), Material reward(behavior), Incentive(outcome), Self-reward, Reward (outcome)
Lottery/Game of Chance	Betting, Leaps of Faith, Luck	

Gamification User Type: Socializer		
Reward/Reputation System	**Game Design Patterns**	**Behavior Change Techniques Taxonomy**
Social Status	Handles, High Score Lists, Individual Penalties, Individual Rewards, King of the Hill, Near Miss Indicators, Privileged Abilities, Privileged Movement, Public Information, Red Queen Dilemmas, Shared Penalties, Shared Resources, Shared Rewards, Social Statuses, Status Indicators	Social comparison
Social Network	Alliances, Asynchronous Games, Collaborative Actions, Communication Channels, Indirect Information, Individual Penalties, Interferable Goals, Last Man Standing, Multiplayer Games, Near Miss Indicators, Negotiation, Public Information, Secret Alliances, Social Dilemmas, Social Interaction, Spectators, Symmetric Information, Tiebreakers, Tied Results, Uncommitted Alliances, Synchronous Games	Social Support(un-specified), Social Support(practical), Social Support(emotional)
Social Pressure	Betrayal, Uncommitted Alliances	Information about others approval
Competition	Agents, Balancing Effects, Capture, Combat, Competition, Conflict, Early Elimination, Eliminate, Last Man Standing, Multiplayer Games, Paper-Rock-Scissors, Player Killing, Race, Time Limits, Tournaments, Transfer of Control, Varied Gameplay	
Social Discovery	Communication Channels, Social Organizations	
Guilds/Teams	Agents, Alliances, Betrayal, Collaborative Actions, Dynamic Alliances, Multiplayer Games, Player Decided Results, Secret Alliances, Shared Penalties, Shared Resources, Shared Rewards, Social Interaction, Social Organizations, Symmetric Information, Symmetric Resource Distribution, Team Balance, Team Development, Team Elimination, Team Play, Tiebreakers, Tied Results, Tournaments, Varied Gameplay	Social Support(un-specified) Social Support(practical), Social Support(emotional)